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XXX.—*On the Structure and Systematic Position of the Genus* Cheirolepis. By R. H. Traquair, M.D., F.G.S., Keeper of the Natural-History Collections in the Edinburgh Museum of Science and Art.

[Plate XVII.]

This very interesting genus of Devonian fishes was originally described by the late Prof. Agassiz, in the second volume of his 'Poissons Fossiles,' p. 178, and was then included by him in his family of "Lepidoides." The first step towards the breaking-up of that heterogeneous assemblage was taken by Agassiz himself, in the course of the publication of the same great work, when he constituted the family of Acanthodidæ for the genera *Cheiracanthus*, *Acanthodes*, and *Cheirolepis*; and this classification was retained in his special work on the Fossil Fishes of the Old Red Sandstone. The founder of fossil ichthyology seems, however, to have had but a slight and not very correct conception of the structure of the fishes with which he associated *Cheirolepis*, as may be seen both from his restored figures and his remark that, as the bones which he had been able to distinguish in *Cheirolepis*, "such as the frontal, humerus, temporal, have the same structure as in ordinary osseous fishes," one may conclude "that the Acanthodians in general had a complete osseous system, and not merely a *chorda dorsalis* as in the *Coccostei* and other fishes of the same epoch"*. Subsequent investigations into

* Poissons Fossiles du vieux Grès Rouge, p. 44.

the structure of the true Acanthodidæ have long since shown that this generalization was rather hasty. *Cheirolepis*, however, he considered as forming, by the absence of spiny rays to the fins and by its unequal dentition, the "passage of the Acanthodians to the Sauroids."

Although the restored figure of *Cheirolepis* given by Agassiz in the 'Poissons Fossiles du vieux Grès Rouge,' tab. D. fig. 4, is quite erroneous as regards the shape of the maxilla and of the opercular bones, he having evidently supposed that the bones of the head were conformed much as in the recent Salmonidæ, yet as regards his assertion of the presence of branchiostegal rays and of an unequal dentition (facts afterwards questioned by others) he was undoubtedly right.

Our own countryman Hugh Miller, however, was shrewd enough to be impressed with the discrepancy of structure in *Cheirolepis* and the *Cheiracanthi* and *Diplacanthi*, with which it had been classed; and accordingly we find him, in his 'Old Red Sandstone,' mentioning it as the type of a distinct family. Nor did these discrepancies escape the attention of Johannes Müller, as may be seen from a brief passage in his paper "Ueber den Bau und die Grenzen der Ganoiden"*. By Giebel† it was also disassociated from the Acanthodians and classed amongst his "Heterocerci Monopterygii," a group unfortunately nearly as heterogeneous as Agassiz's "Lepidoides." Nevertheless for years afterwards many eminent palæontologists (such as Pictet‡, Quenstedt§, M'Coy‖, and Sir Philip Egerton¶) continued to class *Cheirolepis* along with the Acanthodidæ.

Pander, however, in one of his justly celebrated essays on the Devonian fishes**, entered into the structure of *Cheirolepis*, and proposed to constitute for it an independent family, the *Cheirolepini*. Many of its head- and shoulder-bones were

* Abhandl. der Berl. Akad. 1844, Phys. Kl. p. 151.

† 'Fauna der Vorwelt,' 1848, vol. i. p. 231.

‡ 'Traité de Paléontologie,' 2me éd. t. ii. p. 190.

§ 'Handbuch der Petrefactenkunde' (1852), p. 192. That Quenstedt was nevertheless rather doubtful on this point may be inferred from the following passage, in his description of the Acanthodidæ :—"Nur *Cheirolepis* hat Fulcra an allen Flossen, und auf dem Rücken des Schwanzes; dennoch hält ihn Agassiz auch für einen Acanthodier. Mögen auch alle diese Fische (*ausser Cheirolepis*) den lebenden Haien sich nicht unmittelbar anschliessen, so stehen sie ihnen doch gewiss näher als den folgenden Ganoiden."

‖ 'Palæozoic Fossils,' p. 580.

¶ "Remarks on the Nomenclature of the Devonian Fishes," Quart. Journ. Geol. Soc. xvi. p. 123.

** 'Ueber die Saurodipterinen, Dendrodonten, Glyptolepiden, und Cheirolepiden des devonischen Systems,' St. Petersburg, 1860, pp. 69–73.

correctly identified by him; but he failed to find the branchiostegal rays and the two sizes of teeth described by Agassiz. But it is specially worthy of note that Pander seems to have been struck by the considerable resemblance which certain bones of the head of *Cheirolepis* bore to those shown in Quenstedt's drawing of the head of *Palæoniscus islebiensis* in the 'Handbuch der Petrefactenkunde.'

The question of the systematic position of *Cheirolepis* was next discussed by Prof. Huxley*. Unfortunately, the material at his disposal at the time he wrote did not afford him the opportunity of making much advance on what had been already done by Pander, though assuredly he was on the right track. He accepted the institution by Pander of a distinct family of *Cheirolepini*; and as regards the suborder in which this family should be included, he considered that it ought "perhaps to be regarded as the earliest known form of the great suborder of Lepidosteidæ." The single short dorsal fin, the absence of jugular plates, and the non-lobate character of the paired fins were points justly considered by Prof. Huxley as excluding *Cheirolepis* from the Crossopterygidæ.

In 1867, however, Mr. Powrie published a paper† in which he questioned the accuracy of the data on which Prof. Huxley's opinions were founded. *Cheirolepis*, Mr. Powrie affirmed, does possess two large principal jugular plates; and the structures described by Agassiz as branchiostegal rays, but not seen by Pander or Huxley, "correspond to the lateral jugular plates not uncommon in Ganoid fishes." Although in this paper Mr. Powrie thinks that Prof. Huxley's objections to *Cheirolepis* being a Crossopterygian are so far negatived, he nevertheless does not positively indicate the systematic position in which he thinks it ought to be placed.

In Dr. Lütken's essay on the Classification and Limits of the Ganoids‡, *Cheirolepis* is placed, somewhat hesitatingly, among the Lepidosteids, Mr. Powrie's jugular plates proving to him rather a stumbling-block. In the English abstract of this elaborate paper, Dr. Lütken states the absence of jugular plates to be one of the characteristics of the group of Lepidosteidæ, "with the sole exception of *Cheirolepis*, the only Devonian fish of the whole series which indicates by its gular plates a certain relationship to the contemporaneous Polypteridæ"§. Again, in the full German edition published

* Dec. Geol. Survey, x. (1861) pp. 38–40.
† Geol. Magazine, iv. 1867, pp. 147–152.
‡ Vidensk. Meddelelser nat. For. Kjöbenhavn, 1868.
§ Ann. & Mag. Nat. Hist. 4th ser. vii. p. 331.

in 1873, he says:—"The position of this genus is *somewhat doubtful*; the fulcral armature of all the fins seems to show that its place is here as the oldest member of the Lepidosteid series; but its *gular plates*, which Powrie has pointed out, indicate possibly a certain relationship with—descent from (?) —the Devonian *Polypterini*"*.

My own observations have been made on a large number of examples of the well-known species *Ch. Cummingiæ*, Agass., from Cromarty, Lethen Bar, and Tynet Burn. Besides the specimens in the Edinburgh Museum of Science and Art, most of which form part of the Hugh-Miller collection, I have carefully gone over the specimens of *Cheirolepis* in the British Museum and in the Museum of Practical Geology, Jermyn Street; and I am also specially indebted to the Earl of Enniskillen for having, with great kindness, lent me a number of excellent specimens from his collection. The careful examination of these numerous specimens has enabled me, I think, to place the question of the systematic position of *Cheirolepis* on a more satisfactory footing than heretofore, though it is to be regretted that, on many points of detail, our knowledge of the cranial structure of this genus is still rather incomplete.

The key to the whole subject is certainly a knowledge of the structure of *Palæoniscus* and its allies; and had the writers who have previously treated of *Cheirolepis* been better acquainted with the structural details of that remarkable group of extinct fishes, the errors and doubts which have so long hung over its affinities would certainly not have prevailed so long as they have. The general form of the body, with its inequilobate, completely heterocercal tail, the number and shape of the fins, with their strongly fulcrated margins, are common characters, evident to every one without the assistance of the osteology of the head; only the small size, and apparently non-overlapping character, of the scales seemed for long to indicate that its place was with the Acanthodidæ. The scales of *Cheirolepis*, however, are well known to be arranged in very distinct oblique rows or bands, following the same general direction from above downwards and backwards as in rhombiferous Ganoids generally, and meeting in acute angles along the dorsal and ventral mesial lines. On the continuation of the body-axis along the upper lobe of the caudal fin, however, the direction of these bands is suddenly changed to

* Dunker und Zittel's 'Palæontographica,' xxii. erste Lieferung, 1873, p. 25, note.

one from above downwards and forwards—exactly the opposite; and this change takes place nearly opposite the middle of the origin of the lower lobe of the caudal. Though this fact is not alluded to by Pander in his description, it is most distinctly represented in tab. ix. fig. 1 of his illustrations. On examining the tail of *Palæoniscus*, *Amblypterus*, or any allied genera, precisely the same phenomenon is invariably seen to occur—viz. the sudden alteration of the direction of the oblique bands of scales on the upper caudal lobe to one at right angles to that of the bands covering the rest of the body*. In *Cheirolepis*, too, as in these genera, the scales clothing the sides of this caudal body-prolongation become acutely lozenge-shaped as we trace them on towards the tip of the tail. I have not observed in front of the azygos fins the peculiar large scales which in most Palæoniscidæ precede the dorsal, anal, and lower lobe of the caudal, ultimately passing into the fulcra of these fins; but on the upper margin of the tail the arrangement of large V-scales is characteristic, and entirely in accordance with that in the heterocercal Lepidosteids and also in *Acipenser* and *Polyodon*. These have been so well illustrated in one of Prof. M'Coy's figures† that there is no necessity for describing them further in this place; enough has been said to show how strikingly *Cheirolepis* deviates from the Acanthodidæ in all points connected with the scales save their minute size, and how close, on the other hand, is the approach which it makes to *Palæoniscus* in the general arrangement of these appendages. And even as regards the smallness of the scales, it is to some extent kept in countenance by the undoubtedly Palæoniscoid *Myriolepis Clarkei*, Egerton, so far as we can judge from the beautiful figure given by its eminent describer‡.

The fins of *Cheirolepis* are composed of very numerous rays frequently dichotomizing, and divided transversely by very numerous articulations; the rays are very closely set, and the demi-rays of each side imbricate over each other from before backwards, like those of the anal fin of *Polypterus*, while conspicuous fulcral scales serrate their anterior margins. The arrangement here is in all essential respects identical with

* It is an interesting fact that the patch of rhombic scales on the side of the vertebral prolongation in the tail of *Acipenser* and of *Polyodon* (in the latter genus the only scales, along with the "fulcra" above them, which occur on the body at all) correspond exactly in arrangement with this peculiarly arranged caudal patch of scales in the Palæoniscidæ. A similar arrangement is also traceable in the imperfectly heterocercal tail of *Lepidosteus*.

† 'Palæozoic Fossils,' pl. 2 D. fig. 3.

‡ Quart. Journ. Geol. Soc. xx. 1863, pl. i. fig. 1.

that in the Palæoniscidæ; but the minute articles of the rays are finer and more scale-like, and, as M'Coy has aptly expressed it, present "a deceptive resemblance to the scales of the body." This view of the structure of the fins of *Cheirolepis*, however, is denied by Pander, who affirms that the apparent joints of the fin-rays are in reality nothing but *scales* which covered internal rays apparently of a flexible nature; and such internal non-jointed rays he has actually represented in tab. ix. fig. 2 of his work. Here I feel myself compelled to dissent from the opinion of so high an authority as Pander, and to agree with Agassiz and M'Coy—as, in spite of the most careful examination of a large number of specimens from various localities, I have never seen any thing like the unarticulated rays represented in his figure, and, moreover, a transverse section of a small portion of the lower lobe of the caudal, from a Cromarty nodule (Pl. XVII. fig. 6), effectually (to my eyes at least) demonstrates the contrary. Here the whole thickness of the fin is seen to consist of the right and left sets of imbricating demi-rays, no other hard parts being visible. And although it is of course not impossible that such internal soft rays may have been present, yet the structure as here shown exhibits the most complete analogy, or rather identity, with that of the anal fin in *Polypterus* and *Calamoichthys*, in which certainly no other rays exist save those whose ganoid, closely jointed, and imbricating surfaces are seen on the outside*.

The *shoulder-girdle* must next claim our special attention, seeing that one of its elements seems to have escaped the observation of previous writers, save Powrie, and to have been by him completely misinterpreted. Of this the first element, by which the arch was attached to the skull, is the *first supraclavicular*, or "suprascapular" (Pl. XVII. fig. 3, 1*st s.cl*), a small rounded-triangular plate placed immediately behind the posterior margin of the cranial shield, and distinctly seen only in very few specimens. It is correctly indicated by Pander, in tab. ix. fig. 6 of his work, by the number 46. Articulated with this is the *second supraclavicular* (2*nd s.cl*), or "scapular," a more elongated plate, broadish above, but getting suddenly narrower about the middle, and whose long axis points obliquely downwards and backwards to articulate

* Agassiz was nevertheless inclined to believe that in *some* species of *Palæoniscus* (e. g. *P. Blainvillei* and *P. Voltzii*) the fin-rays were really covered with scales (Poiss. Foss. t. ii. pt. 1, p. 43). I do not, however, find this idea corroborated by the specimens of *Palæoniscus Blainvillei* in the British Museum, which I have carefully examined; *P. Voltzii* I have not seen.

with the clavicle. This bone is seen in Pander's tab. viii. fig. 2 and tab. ix. figs. 3 & 5, but also marked 46, the same as the preceding *. Articulated with its lower extremity is the *clavicle* (figs. 2 & 3, *cl*), a bone so strong that it is conspicuous in every nodule specimen, and seems to have been able to resist compression in very many cases where every thing else is crushed quite flat. This clavicle is composed of two parts, set at a considerable angle to each other. Of these, the upper or vertical part, set on the side of the shoulder and forming part of the hinder margin of the branchial opening, is of a somewhat lanceolate shape, with the posterior margin more convex than the anterior, and with the apex directed obliquely upwards and backwards to the lower end of the bone last described. A nearly vertical line divides the outer surface of this part into two, the anterior of which looks rather forwards into the branchial cavity. The lower part of the bone, much smaller and somewhat quadrate in form, projects inwards towards the ventral middle line; between the two parts, behind, is a notch from which the pectoral fin issued. This bone, the *clavicle*, is numbered 48 in Pander's figures; but in tab. ix. figs. 3 & 5 the number is placed on the element next to be described, which is not represented as distinct; and in tab. viii. fig. 2 it is also placed on a bone which is undoubtedly the operculum. The last element of the shoulder-girdle articulated to the front of the lower end of the clavicle is the *interclavicular* plate (figs. 2 & 3, *i.cl*), a bone which among recent Ganoids is not found in *Lepidosteus* or *Amia*, though it occurs both in *Polypterus* and *Acipenser* and also in *Polyodon*, and in them lies, as it does here, on the so-called "isthmus." It consists of a pointed plate of bone, sharply bent on itself along a line continued forwards from the line of junction of the two portions of the clavicle, when the two bones are in apposition. It thus comes also to present two portions or aspects—the one looking upwards and outwards, forming part of the gill-slit below the branchiostegal rays, and the other covering the ventral surface of the isthmus. Seen from below, the ventral portion of the interclavicular plate is of a somewhat elongated triangular form, the apex directed forwards towards the symphysis of the jaw, the short posterior side articulating with the lower end of the clavicle, and in close apposition to its fellow of the opposite side, by about two thirds of its long internal margin, in specimens

* There is probably an error in the lettering here, as the number 47, which Pander assigns to the "scapula," does not occur on the plate at all.

where this relation has been left undisturbed *. These interclavicular plates are certainly the structures which have been figured and described by Powrie as "principal jugulars"—a mistake into which he never could have fallen had he observed their relation to the clavicles, or had he taken into consideration the structure of the shoulder-girdle in the recent *Polypterus* or in the extinct Palæoniscidæ. And in the presence and configuration of this, as of all the other elements of the shoulder-girdle, the closest resemblance is seen between *Cheirolepis* and the genera of fossil fishes allied to *Palæoniscus*, for corroboration of which the reader need only refer to my description of the same parts in *Cycloptychius carbonarius*†, and in *Pygopterus* (*Nematoptychius*) *Greenockii* and *Amblypterus punctatus*‡.

Passing now to the bones of the *face*, we find the most singular conformity to the general type of structure in *Palæoniscus* and its allies—a fact which, as already mentioned, did not altogether escape the notice of Pander. In the first place, the gape is very wide, the direction of the axis of the suspensorium and of the opercular apparatus passing obliquely downwards and backwards, so as to carry the articulation of the lower jaw far enough behind. The *superior maxillary* bone (Pl. XVII. figs. 1 & 7, *mx*) has been very correctly figured by Pander, and is formed on the same type as in all the Palæoniscidæ. It consists of a plate of bone, broad behind the eye, and there covering a large part of the cheek; but immediately behind the orbital ring the superior margin becomes suddenly cut out, so that the anterior extremity passes forwards below the orbit, tapering to a point towards the premaxillary region. The inferior or dental margin is not quite straight, but shows a slight sigmoid curve; the posterior inferior angle is rounded, while the short posterior margin, sloping obliquely upwards and forwards, joins the straight part of the superior margin at a very obtuse angle. Closely articulated to the maxilla is a rather narrow plate (fig. 7, *x*), consisting of two parts diverging at an obtuse angle. The upper and anterior of these lies along the superior margin of the maxilla behind the orbit, the lower and posterior one passing down for some distance along the oblique posterior margin of the same bone, between it and the suboperculum, the centre of ossification

* Though in the specimen represented in Plate XVII. fig. 2 the interclavicles have been forced apart, their juxtaposition is beautifully shown in No. 41725 of the British-Museum collection, and many others which I have seen. They are also in contact with each other in Mr. Powrie's figure; but there both are also disjoined from their respective clavicles.

† Geol. Magazine, 2nd series, vol. i. June 1874.

‡ Trans. Royal Soc. Edinburgh, 1867, xxiv. pp. 707, 708. In this paper I called the interclavicular *precoracoid*.

being placed near the angle of divergence. This plate is marked *x* in Pander's figures, and seems to correspond to a similar though somewhat smaller one seen in most Palæoniscidæ, and which in Quenstedt's previously quoted figure of the head of *Palæoniscus islebiensis* is marked as "*præoperculum*." How far it represents a præoperculum is doubtful, though it certainly does occupy a very analogous position to that of the great præopercular cheek-plate in *Polypterus*. Above the margin of the anterior limb of this plate is frequently seen another portion of bone (fig. 7, *y*), the interpretation of which does not seem very clear, but which may very possibly be a portion of the *hyomandibular* exposed from under the previously described plate. The *lower jaw*, long and powerful in accordance with the great backward extent of the gape, was undoubtedly the strongest of all the bony parts of the head, as its contour, like that of the clavicle, is easily recognizable in most specimens. Its dentary portion (figs. 1 & 7, *d*) has been well figured by Pander, and is peculiar in presenting on its lower margin a wide shallow notch rather in front of its middle, and immediately above which the centre of ossification was placed. Besides the dentary portion, distinct *articular* and *angular* elements (fig. 7, *ag*) are recognizable; but I have never succeeded in detecting any inner or *splenial* plate, though I have often seen it in many Carboniferous Palæoniscidæ. The *operculum* (fig. 7, *op*) seems to have been a very delicate plate, as it is only in very few specimens that any trace of it is seen. However, it is unmistakably shown in one of Lord Enniskillen's specimens, and in Nos. 255 and 435 of the Hugh-Miller collection; and though Pander states that he was unable to detect it, yet the plate marked 48 in his tab. viii. fig. 2, as an element of the shoulder-girdle, clearly corresponds with it both in form and position. It is a narrow, elongated, thin plate, with acute anterior-superior and posterior-inferior angles, and placed obliquely on the side of the head, between the suspensorium and the shoulder-girdle. The *subopercukum* (*s.op*) is also rarely shown, and I have come across no specimen in which the whole of its contour is distinctly exhibited; to judge, however, from its remains, it seems to have been a somewhat square-shaped plate, placed immediately below the inferior margin of the operculum. This is undoubtedly the plate marked 3 in Mr. Powrie's figures, and which he supposes "may have represented the operculum."

The *branchiostegal rays*, described and figured by Agassiz, were not observed by Pander nor by Prof. Huxley, though he accepts and quotes Agassiz's statement regarding them.

They were figured and described by Powrie, who considered them, however, to be "lateral jugular plates"—an opinion which, I think, he would scarcely have advocated save as a corollary to his view that the interclavicular plates were "principal" jugulars. The branchiostegal rays are beautifully displayed in a specimen in Lord Enniskillen's collection (Pl. XVII. fig. 1), in no. 41725 of the British-Museum collection, and also in nos. 134 and 360 of the Hugh-Miller collection. Twelve of them are counted below each mandibular ramus in Lord Enniskillen's specimen, though there may have been more; and of these the anterior one on each side is large, broad, and somewhat triangular in shape, the rest being long and narrow. In a specimen of *Amblypterus punctatus*, Agass., from Wardie, now before me, and of which I have given a diagrammatic sketch in a paper already quoted, exactly the same arrangement of branchiostegal rays or plates is seen, with this exception—that between the two large anterior ones a lozenge-shaped azygos one is placed immediately behind the symphysis of the jaw; but of this I have never seen any very clear evidence in *Cheirolepis*.

There is very distinct evidence in *Cheirolepis* of a circle of plates surrounding the orbit, as in *Palæoniscus*, but concerning which it is impossible to furnish any more special details; Pander indeed mentions the arrangement as being formed by one large perforated plate.

Specimen no. 41310 of the British-Museum collection shows that the top of the head was traversed longitudinally by a pair of slime-canals following a flexuous course, similar to those in *Palæoniscus*; but I have never seen any specimen showing the individual bones of the cranial roof so well as to enable one to make a satisfactory figure of them. What I have been able to observe confirms Pander's statement as to the two *parietals*, followed by a pair of more elongated *frontals*. External to these there seem to lie on each side two plates, the posterior of which would seem to represent the *squamous* plate seen outside the parietal in *Lepidosteus* and *Amia*, while the anterior may correspond to the *postfrontal* scale-bone seen in the last-mentioned fish. These have nothing to do with the three bones mentioned by Pander as occupying a similar position, and marked 46, *x* and *y*, in his figures, which, as he himself surmises, undoubtedly belong to the shoulder-girdle and face. The snout seems to have been rounded and blunt; but no specimen which I have seen has revealed any thing describable regarding the bones of the nasal region, including the præmaxilla. The same must unfortunately be also said of the side walls and base of the skull, of the

palato-quadrate apparatus, and of the hyoid and branchial arches.

Regarding the *dentition* of *Cheirolepis* there has also prevailed some little obscurity. Agassiz describes the teeth as being indeed of two sizes, but all arranged in one line, and in that respect differing from the unequal dentition of his "Sauroids" and "Cœlacanths," in which the smaller teeth form a continuous external range. Pander and Huxley describe the jaws as being set with small conical teeth, but they were unable to find any of the larger ones referred to by Agassiz; while Powrie, on the other hand, returns to the statement of Agassiz regarding the larger and smaller teeth being in one row. According to the specimens which have come under my own observation, the jaws of *Cheirolepis* were set along the inner aspect of their dental margins with one row of tolerably equal and rather closely set, sharp, and acutely conical teeth, each having a marked inward curve, and, when broken, displaying a large simple internal pulp-cavity. These are undoubtedly the teeth referred to and figured by Pander, who, however, seemed to expect that, according to Agassiz's description, *larger* ones would be found among them. Now, other teeth of a different size do exist—not larger, however, but *smaller*; and these form a row *external* to those first described. The outer row of smaller teeth, the discovery of which at once breaks down Agassiz's demarcation between the dentition of *Cheirolepis* and that of his so-called "Sauroids" and "Cœlacanths," is not often seen, from the fact that the edge of the jaw on which they are placed is almost invariably found split off and adherent to the matrix of the "counterpart," and thus the little teeth in question are hidden. But by careful working out with the point of a needle, I have been able to display some of them in two cases where a portion of the edge of the jaw remained, as shown in Plate XVII. figs. 4 and 5. They are indeed very minute, being only about one third or one fourth the length of the larger ones, which themselves only measure $\frac{1}{12}$ inch in specimens of the ordinary size. The dentition of *Cheirolepis* is thus reduced to a type very frequent in Ganoid fishes, and which notably occurs in many, if not in most, of the genera comprised in the family of Palæoniscidæ.

The facts adduced in the preceding pages seem most satisfactorily to prove not only that *Cheirolepis*, as Prof. Huxley has already indicated, must take its place among those Ganoids which he has brought together under his suborder of Lepidosteidæ, but also that among those Lepidosteids it must

be classed along with *Palæoniscus*, *Pygopterus*, *Oxygnathus*, *Cycloptychius*, and other genera which constitute the long-extinct family of Palæoniscidæ. So close indeed is the correspondence between the general organization of *Cheirolepis* and of *Palæoniscus*, that at most only the distinction of a separate "subfamily" can be accorded to it, in virtue of the peculiarity of its scales. Though the precursor of a numerous tribe of most interesting fishes in the Carboniferous and Permian eras, and which finally disappear with the Lias, *Cheirolepis* stands alone in the Devonian fauna, so far as that has been as yet revealed to us*; and no peculiarity of its structure throws the smallest additional light on the evolution of the group to which it belongs; for the absolute divergence in all other points of structure utterly excludes the idea that its minute scales betray any special affinity to the Acanthodians, while the correct determination of the plates, which have been mistaken for jugulars, equally forbids any association of it with the "contemporaneous Polypteridæ."

EXPLANATION OF PLATE XVII.

Fig. 1. Represents the mandibles and branchiostegal rays of both sides of *Cheirolepis Cummingiæ*, also the right maxilla and part of the circumocular ring. From a specimen from Lethen Bar, in the collection of the Earl of Enniskillen.

Fig. 2. Both interclavicular bones, with the left clavicle and the lower extremity of the right clavicle. From a specimen from Cromarty in the Hugh-Miller collection, Edinburgh Museum of Science and Art.

Fig. 3. Outline of the shoulder-girdle and its component bones, restored.

Fig. 4. A small portion of the edge of the superior maxillary bone, magnified two diameters. The outer row of small teeth is exhibited, also one of the larger ones and the broken stump of another. Hugh-Miller collection.

Fig. 5. Portion of the dentary bone of the mandible of another specimen. Along one half of the bone the outermost edge has been broken away, thus carrying off the small ones and exhibiting the inner row of larger teeth; along the other half this edge remains, and shows some of the small teeth, while the continuation of the row of large ones is concealed by the matrix. The working-out of the small teeth has not been so successful here as in the preceding specimen.

Fig. 6. Vertical transverse section of a small portion of the lower lobe of the caudal fin, magnified two diameters.

Fig. 7. Restored outlines of some of the bones of the side of the head. The radiating lines on some of the bones are those which, on

* With the apparent exception of four species of *Acrolepis*, described by Eichwald from the "Old Red" of Russia ('Lethæa Rossica,' vol. i. pp. 1578–1581).

their under surfaces, are seen passing from their centres of ossification.

In all these figures the same letters apply to the same bones. *m.r*, maxilla; *mn*, mandible; *d*, dentary; *ay*, angular; *su.o*, suborbital; *x*, cheek-plate above the maxilla; *y*, portion of hyomandibular (?); *op*, operculum; *s.op*, suboperculum; *br*, branchiostegal plates or rays; *1st s.cl*, first supraclavicular; *2nd s.cl*, second supraclavicular; *cl*, clavicle; *i.cl*, interclavicular.

XXXI.—*On a new Species of* Liphistius (*Schiödte*).

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The British-Museum collection contains a fine specimen of this remarkable genus from Penang, the same locality whence the typical species *L. desultor*, Schiödte*, was obtained. In almost every essential particular the British-Museum example agrees with *L. desultor*, except in being larger and possessing four mammillary organs of considerable size beneath the abdomen, immediately behind the second pair of spiracular apertures. Prof. Schiödte makes no mention of such organs, describing *L. desultor* as "mammillis textoriis nullis." Whether the organs in the British-Museum specimen are, or not, true spinning-organs seems doubtful, inasmuch as an examination lately made under a microscope by Mr. A. G. Butler has failed to reveal any spinning-tubes.

It is not without some reluctance that I have determined to characterize the example in the British Museum as a new species. It appeared to me possible that the mammillary organs might have been overlooked or destroyed in the specimen from which Prof. Schiödte described *Liphistius desultor*; I am, however, compelled to shut out the idea of this possibility, after receiving a communication on the subject (through Dr. Thorell) from Prof. Schiödte. From this communication it appears that when the specimen came into Prof. Schiödte's hands it was in a dry state, having been opened along the middle line of the underside of the abdomen and, after extraction of the contents, stuffed with cotton; it was then placed in spirit of wine. Prof. Schiödte thinks it almost impossible for the collector (Dr. Teylingen, himself a good zoologist) to have overlooked or destroyed the mammillæ, if they had been present; the incision through the abdomen had the appearance of being exceedingly clean and even; and the surface showed no loss whatever of substance. Under these

* *Vide* description and figures of *Liphistius desultor*, in Kröyer's 'Naturhist. Tidsskr. N. R.' Bd. ii. 1849, pp. 617–624, tab. 4.